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U. S. Regional Business Cycles and the Natural Rate of Unemployment*

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Abstract

Estimates of the natural rate of unemployment are important in many macroeconomic models used by economists and policy advisors. This paper shows how such estimates might benefit from closer attention to regional developments. Regional business cycles do not move in lockstep and greater dispersion among regions can affect estimates of the natural rate of unemployment. There is microeconomic evidence that employers are more reluctant to cut wages than they are to raise them. Accordingly, this means that the relationship between wage inflation and vacancies is convex: an increase in vacancies raises wage inflation at an increasing rate. Our empirical results are consistent with this and indicate that if all else had remained constant, the reduction in the dispersion of regional unemployment rates between 1982 and 2000 would have meant a two-percentage point drop in the natural rate of aggregate unemployment.

JEL: J6, E2
Keywords: Regional unemployment, inflation, natural rate of unemployment, Phillips curve

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Milton Friedman and Edmund Phelps convinced the economics profession in the late 1960s of the absence of a long-run trade off between inflation and unemployment. A policy that tries to maintain the unemployment rate below a certain threshold – dubbed the natural rate of unemployment by Friedman – would lead to rising inflation, while trying to maintain it above the threshold would lead to ever-declining rates of inflation. The proposition of a long-run neutrality of inflation and money growth soon gained wide acceptance and work in this area has focused on making the natural rate of unemployment fully endogenous in general-equilibrium models (Pissarides, 2000; Layard, Nickell, and Jackman, 1991; and Phelps, 1994). This theory can be used to show how a variety of macroeconomic shocks – such as the rate of technical progress, real interest rates, and oil prices – affect the natural rate and social welfare.

Inflation-targeting central banks often monitor employment and wage changes in the hope of preventing wage inflation in the labor market from generating general price inflation.[1] The use of the notion of an equilibrium level of unemployment that is independent of current and past monetary variables has made the estimation of the natural rate important. This practice relies on models of the representative-agent type – the ones used to provide microeconomic foundations for the inflation-unemployment relationship – to assess the state of the economy on the basis of aggregate data. A central banker may then use data on aggregate employment, unemployment and average wage inflation across all sectors of the economy to assess the position of the economy in relation to an estimate of the natural rate of unemployment. Most often, the estimate is the implied natural rate in an econometric model of the aggregate Phillips curve.

[1] Such considerations have led to the appointment of a labor economist – Steve Nickell – to Britain's Monetary Policy Committee.

The objective of this paper is to show that the sole reliance on aggregate data may lead to incorrect inferences about the natural rate of unemployment. We show how regional business cycles might affect aggregate wage inflation, and how attention paid to regional labor-market trends can be useful for understanding the aggregate labor market. Moreover, we show how the natural rate of unemployment may depend directly on the dispersion of economic activity across regions.

Our regional approach has some parallel with the sectoral approach of Lilien (1982), Abraham and Katz (1986), and Brainard and Cutler (1993). Lilien (1982) found that a measure of sector-specific disturbances accounted for a significant portion of the variation in aggregate employment: When it takes less time for an industry to shed redundant labor than it does for the affected workers to find employment elsewhere, unemployment rises when the pace of sectoral reallocation of labor (and capital) increases. Abraham and Katz (1986) pointed out that Lilien's estimates might exaggerate the role of sectoral disturbances by failing to take into account differences in the sensitivity of different industries to macroeconomic shocks. Brainard and Cutler (1993) developed a data series to measure the intensity of reallocation shocks. They constructed a time series of the variance of sectoral stock market excess returns and found that they had a modest – though statistically significant – role in explaining aggregate employment fluctuations.

Our paper follows recent work illustrating the significant regional differences in economic conditions, business cycle dynamics, and reactions to monetary policy. Overman and Puga (2002) demonstrate the increased polarization of unemployment within Europe where unemployment increasingly appears in regional clusters that cross national borders. Crone (1998/1999) groups the U.S. states into regions based on common cyclical behavior, while

Carlino and Sill (2001) find considerable state differences in the volatility of regional cycles (of GDP per capita). Owyang, Piger, and Wall (2003) identify distinct state-level recession/expansion phases, finding a great deal of business cycle discord among the states and between states and the country as a whole. They also find significant cross-state differences in the depths of recessions and the speed of expansions. Recent research has also found that states and regions respond differently to monetary policy (Carlino and DeFina, 1998; Fratantoni and Schuh, 2003; Owyang and Wall, 2003).

It follows from these studies that the national economy of the United States is a composite of significantly diverse but interrelated regional economies. In this paper, we show how the diversity in regional labor-market conditions can be used to enrich policy makers' understanding of the aggregate economy. In the section immediately following, we briefly lay out a state-level view of recent U.S. labor market trends. In section 2 we describe how differences in regional business cycles can lead to changes in aggregate wage inflation. In section 3 we test for the underlying conditions for this to occur, and demonstrate how region-level data can be used to estimate the aggregate natural rate of unemployment in the United States. Section 4 concludes.

1. A state-level view of U.S. unemployment

This paper relies on two suppositions about the dispersion of regional labor market conditions: (i) that the dispersion is related to aggregate labor-market conditions, and (ii) that the dispersion changes over time. Both suppositions are supported by Figure 1, which illustrates that the movements in the aggregate unemployment rate over the last 25 years have largely been in synch with changes in the dispersion of state unemployment rates (as measured by the cross-state coefficient of variation). Correspondingly, the 1990s saw steadily declining unemployment alongside a convergence of state unemployment rates. The only period during which aggregate unemployment was out of synch with the coefficient of variation was in 1986-87, when a handful of states had sudden increases in unemployment following the crash of energy prices in 1986.[2] Along with the country as a whole, all other states saw falling unemployment during this period.

More evidence of the potential importance of regional labor-market variation is provided by Figure 2, which illustrates the distribution of changes in state unemployment surrounding the three most recent recession episodes.[3] Associated with the 1981-82 recession, the US unemployment rate rose by about 3.3 percentage points from the third quarter of 1981 to the fourth quarter of 1982. Over the same period, 29 states saw their unemployment rates rise by less than this, with 14 states seeing increases that were less than half as large (Nevada actually saw a small decrease). On the other hand, of the 21 states whose unemployment rates rose relatively more than the national average, six states saw them rise by more than 4.8 percentage points.

The period surrounding the 1990-91 recession is perhaps the most regionally distinct of the three. The aggregate unemployment rate rose by 2.3 percentage points from the second quarter of 1990 to the third quarter of 1992. The brunt of the increase was felt on the coasts where most states saw much larger than average increases in their unemployment rates, particularly the large states of California, New York, North Carolina, and Washington. At the other end, a significant majority of states (36), mostly located in the vast middle of the country,

[2] These states were Alaska, Alabama, Colorado, Louisiana, Mississippi, Texas, and Wyoming.
[3] The official dates for these recessions are July 1981-November 1982, July 1990-March 1991, and March 2001-November 2001.

saw a milder than average increase in unemployment. In fact, four states actually saw their unemployment rates fall during the period.

Associated with the 2001 recession was a runup in unemployment that began in the fourth quarter of 2000 and continued well after the official end of the recession. By the first quarter of 2002, the fact of a regionally diverse unemployment experience, and an increasing coefficient of variation, had become clear. By that time, the aggregate unemployment rate had risen by 1.6 percentage points, although 35 states saw smaller increases than this, and six had seen declines. The states hit most severely were scattered across the country, with pockets in the Great Lakes region, the Atlantic Seaboard, the western Plains, and the Southwest.

2. How regional business cycles might matter

Here, we describe how a non-linear relationship between inflation and measures of labor-market pressures – such as vacancies, unemployment, and employment growth – would mean that differences in regional business cycles can affect measures of aggregate conditions. Such nonlinearities are standard in the theory of unemployment and it is not difficult to find empirical evidence backing them up.

Numerous statistical studies of the distribution of wage changes point to a potential role for asymmetric wage adjustments and heterogeneity (see, for example, McLaughlin, 1999; Card and Hyslop, 1997). These studies show that the distribution of wage changes is skewed away from small increases and absolute cuts and towards large increases. There is a thinning of the left-hand tail to the left of the zero-inflation point, thereby indicating nominal wage rigidity. As McLaughlin (1999) documents, the skewness of the distribution exists even in the absence of any nominal wage rigidity: Even if the distribution is truncated at zero wage increases, the distribution is still skewed. According to survey results from Truman Bewley (1999), managers are hesitant to cut wages because of considerations about worker morale. Wage cuts are likely to introduce personnel and incentive problems beyond the intended effect on turnover. It follows that in an economy where some sectors and/or regions are declining and others are expanding, the relative wage cuts (relative to the rise of average wages) occurring in the former are smaller than the wage increases (relative to the rise of average wages) offered in the latter.

This microeconomic evidence suggests a potential role for regional labor-market disaggregation in understanding aggregate labor market outcomes. This can be illustrated most simply with the textbook version of the Phillips curve that traces its origins to Phelps (1968). In this model, wage inflation persists because firms cannot adjust instantaneously to changes in vacancies. This might be due to the costs of setting wages, or because wage setting is staggered over time. Thus, for a given unemployment rate, the rate of wage inflation is increasing in the number of vacancies that firms would like to fill and on inflation expectations. There is a critical vacancy rate $\bar{v}$ at which actual wage inflation equals expected wage inflation. When the vacancy rate is above $\bar{v}$, there is unexpected wage inflation. Conversely, when the vacancy rate is below $\bar{v}$, there is unexpected wage deflation.

The microeconometric evidence we cite above suggests that the slope of the relationship between wage inflation and the vacancy rate differs above and below $\bar{v}$. This is because firms are more reluctant to cut expected wages than to raise them. So, starting from $\bar{v}$, a decrease in the vacancy rate will lead to wage deflation that is smaller in absolute terms than the wage inflation that would follow an equivalent increase in the vacancy rate. In other words, the relationship between wage inflation and the vacancy rate is convex because it is flatter for vacancy rates below $\bar{v}$.

To see how this convexity matters, consider an economy with two equal-sized regions, both with vacancy rates of $\bar{v}$. Now consider equal but opposite-signed changes in the regions' vacancy rates (i.e., the changes are mean-preserving). One region experiences unexpected wage inflation that is greater in absolute terms than the unexpected wage deflation in the other. Thus, a mean-preserving increase in the dispersion of regional vacancy rates is associated with higher average wage inflation. More generally, with a strictly convex relationship between wage inflation and the vacancy rate, the larger is the dispersion of regional vacancy rates, the higher is the aggregate wage inflation for any given aggregate vacancy rate.

3. Convexity and the natural rate in the United States

The discussion above describes how aggregate wage inflation can be affected by the dispersion of regional labor-market conditions when the region-level relationship between wage inflation and labor-market conditions is convex. To test for this convexity, we use state unemployment rates and rates of growth of employment as our measures of state labor market conditions. Unfortunately, there are no state-level data for vacancies. This gives rise to the following equation, which we estimate with state-level panel data:

$$\frac{\dot{w}_{it}}{w_{it}} = \alpha_0^i + \alpha_1 \frac{\dot{N}_{it}}{N_{it}} + \alpha_1 \left(\frac{\dot{N}_{it}}{N_{it}} \right)^2 + \alpha_2 u_{it} + \alpha_2 u_{it}^2 + \alpha_3 \frac{\dot{w}_t^e}{w_t} + \varepsilon_{it} . \qquad (1)$$

In (1), where *i* refers to the state and *t* refers to the time period, $\dot{w}_{it} / w_{it}$ is wage inflation, α_0^i is a state fixed effect, $\dot{N}_{it} / N_{it}$ is employment growth, u_{it} is the unemployment rate, and $\dot{w}_t^e / w_t$ is expected aggregate wage inflation. We use quarterly data from 1977.3 to 2002.1. Our wage measure is hourly earnings in manufacturing, employment data are from the establishment survey, and the unemployment rate is from the household survey. Expected wage inflation at the aggregate level is measured by actual CPI inflation lagged one quarter. We estimate (1) with Feasible Generalized Least Squares (FGLS) so as to correct for state-specific autocorrelation and heteroscedasticity that is correlated across states.[4]

As reported in Table 1 and illustrated by Figures 3 and 4, the coefficients for employment growth and the unemployment rate (in levels and squared) imply a convex relationship between wage inflation and regional labor market conditions. However, the coefficient on the squared employment term is not statistically significant at traditional levels, so the relationship is not statistically different from linearity. On the other hand, the convexity of the relationship between wage inflation and the unemployment rate is statistically significant.

The weight of this empirical evidence indicates that the relationship between labor-market conditions and wage inflation is convex, meaning that changes in the dispersion of conditions across states will have repercussions at the aggregate level. In particular, divergent regional business cycles cause measured wage inflation to rise for a given aggregate unemployment rate. In other words, the aggregate unemployment rate at which wage inflation is unchanged will be higher.

These results suggest one possible reason for the non-inflationary boom that took place in the United States in the 1990s. Recall Figure 1, which shows that the coefficient of variation of state unemployment rates fell throughout the period, indicating a convergence of economic activity. Consistent with our discussion, this decreased dispersion was accompanied by a falling aggregate unemployment rate but no increase in wage inflation.

[4] We are able to correct for this most-general form of heteroskedasticity because our time-series is relatively long for a cross-state panel. A useful rule of thumb is that this is possible if there are twice as many time periods as cross-sectional units (Beck and Katz, 1995), which our panel just satisfies.

In order to explore this possibility further we estimate a relatively simple Phillips curve for the United States, including features common to Phillips curve models:[5]

$$\frac{\dot{w}_t}{w_t} - \theta_t^e = \alpha_0 - \alpha_1 \ln u_t + \lambda X_t + \mathbf{?\,F} + \pi_t^e + \varepsilon_t \,. \qquad (2)$$

In (2), the dependent variable is nominal hourly wage growth averaged over years *t* and *t*+1 net of expected productivity growth, θ_t^e, measured by the trend growth of output per worker in the non-farm business sector. We also include a vector of demographic variables $\mathbf{F}$ to control for changes in the composition of the labor force (Phelps and Zoega, 1997; Shimer, 1998; Francesconi, et al, 2000; and Staiger, Stock, and Watson, 2002). Following Staiger, et al. (2002), these variables are the percentages of the adult population that are: high school dropouts, college graduates, white, female, and aged 25-54. Expected wage inflation, π_t^e, is measured by average CPI inflation for years *t*-1 and *t*-2.

Our innovation is to include X_t, the coefficient of variation of state unemployment rates, which we expect to be positively related to wage inflation: Even if the aggregate unemployment rate is unchanged, an increase in the dispersion of labor market conditions will raise the aggregate rate of wage inflation.

In choosing the time frame for estimating (2), we are hampered by the lack of state-level data before 1977 and of demographic variables after 2000. In addition, to eliminate the estimation problems associated with the so-called Monetarist experiment period, we include only

[5] The variety of Phillips curve specifications is vast; Staiger, Stock, and Watson (2002) alone has dozens of different Phillips curve specifications and estimates. As Phelps (1968) noted thirty-five years ago, and which is no less true today, "(t)he numerous Phillips curve studies of the past ten years have … (offered) countless independent variables in numerous combinations to explain wage movements. But it is difficult to choose among these econometric models, and rarely is there a clear rational for the model used" (p.678).

1982 and later. Despite these data restrictions, we are able to obtain the fairly reasonable results reported by Table 2.

Results for our more general specification – which includes demographic variables and the coefficient of variation of state unemployment rates – indicate that the education and age variables have all been important in determining the rate of wage inflation. More importantly for our present purposes, the results are consistent with our hypothesis that the regional dispersion of economic activity can affect aggregate wage inflation: The coefficient on the coefficient of variation of state unemployment is positive and statistically significant.

Table 2 also reports the results when the aggregate Phillips curve is estimated under the restriction that the coefficient of variation of state unemployment does not matter statistically. From these results it is clear that this restriction is not supported. When the coefficient of variation is excluded, the coefficient on only one of the demographic variables – the share of college graduates – is any where near to being statistically significant. In addition, the constant term becomes smaller and statistically insignificant, making it very difficult to use the results to calculate a natural rate of unemployment. In sum, as supported by a likelihood-ratio test rejecting the null hypothesis that the restriction does not have a statistically significant effect, the estimates with the coefficient of variation are preferred.

According to Ball and Mankiw (2002), the primary sources of the changes in the natural rate of unemployment in the 1990s was the acceleration of productivity growth (see also Pissarides, 2000; Hoon and Phelps, 1997). An additional factor was the changing composition of the labor force (Phelps and Zoega, 1997; Shimer, 1998; Francesconi, et al, 2000). Our Phillips curve estimation indicates that the convergence of state labor-market conditions also had a role. The extent of this role can be obtained by examining the natural rates of unemployment implied by our Phillips curve estimation. Specifically, solving equation (2) by assuming that expected wage inflation is equal to last year's wage inflation, it can be rewritten as:

$$\Delta\left(\frac{\dot{w}_t}{w_t}\right) = -\alpha_1\left(\log(u_t) - \log(u_t^n)\right) + \varepsilon_{it}; \qquad (3)$$

where $u_t^n = \exp[(\alpha_0 + \lambda X + \mathbf{?}\,\mathbf{F})/\alpha_1]$ is the time-variant natural rate of unemployment.[6]

The trend natural rate from our estimation and the actual trend unemployment rate are illustrated by Figure 5. According to our results, the natural rate fell steadily between 1982 and 2000, from 6.7 percent to 5.4 percent. Although relatively large, this 1.3 percentage point drop understates the importance of changes in the dispersion of state-level unemployment rates. This is because the net effect of the period's demographic changes on the natural rate was to increase it. To remove the effect of these changes, the dashed gray line in Figure 5 is what the trend natural rate of unemployment would have been if the demographic variables had remained fixed at their 1982 levels.[7] As the figure indicates, if all else in the model had remained constant, changes in the dispersion of state unemployment rates would have lowered the trend natural rate of unemployment to 4.7 percent by the year 2000.

4. Conclusions

Using state-level data, we find that there is a convex relationship between unexpected wage inflation and labor-market conditions – as measured by the unemployment rate and employment growth. This convexity suggests that increases in the cross-state dispersion of unemployment rates and employment growth mean a higher level of aggregate wage inflation

[6] See Staiger, Stock, and Watson (1997) for an analysis of the precision of natural rate estimates.
[7] Note that because our dependent variable in (2) is wage inflation net of productivity growth, the trend natural rates shown in Figure 5 are also net of the effect of productivity changes.

even if aggregate unemployment and employment growth are unchanged. Finally, we include the coefficient of variation of state unemployment rates in our estimation of an aggregate Phillips curve. From this, we find that the convergence of state labor-market performance between 1982 and 2000 was responsible for a two-percentage point drop in the natural rate of aggregate unemployment.

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Table 1. Wage inflation and vacancies in a state panel

	Coeff.	*s.e.*	*t*
Employment growth	0.0365*	0.0146	2.50
Employment growth	0.0047	0.0036	1.31
Unemployment rate	-0.0679*	0.0207	3.28
Unemployment rate	0.0021*	0.0012	1.66
Expected wage inflation	0.5907*	0.0293	20.14
State fixed effects (48)		Yes	
Observations		4752	
Estimated covariances		1176	
Estimated Autocorrelations		48	
Log-likelihood		-4587.42	

A ‘*’ indicates statistical significance at the 10 percent level. The estimator is FGLS and corrects for state-specific autocorrelation and heteroskedasticity with cross-state correlations. Quarterly state-level data, 1977.3-2002.1. Indiana and Kansas are excluded because of missing earnings data in early years of the sample. For space considerations, we do not report the estimates of the state fixed effects.

Table 2. U.S. Phillips curve estimation

	Coefficient of Variation and Demographics	Demographics Only
Constant	-112.326* (57.196)	-51.097 (68.513)
Log unemployment rate	-3.300* (0.741)	-3.036* (0.958)
Coefficient of variation of state unemployment rates	0.263* (0.080)	-
Share high school dropout	0.957* (0.542)	1.098 (0.817)
Share college graduate	0.542* (0.218)	0.486* (0.242)
Share white	-0.044 (1.057)	-0.082 (1.389)
Share female	1.645 (1.751)	0.798 (2.561)
Share aged 25-54	0.240* (0.116)	0.005 (0.119)
Expected wage inflation	0.452* (0.059)	0.474* (0.117)
Observations	19	19
Log-likelihood	7.781	1.566
R^2	0.944	0.8933

White-corrected standard errors are in parentheses. A '*' indicates significance at the 10 percent level. Yearly aggregate data, 1982-2000.

Figure 1. Quarterly U.S. unemployment and its cross-state coefficient of variation

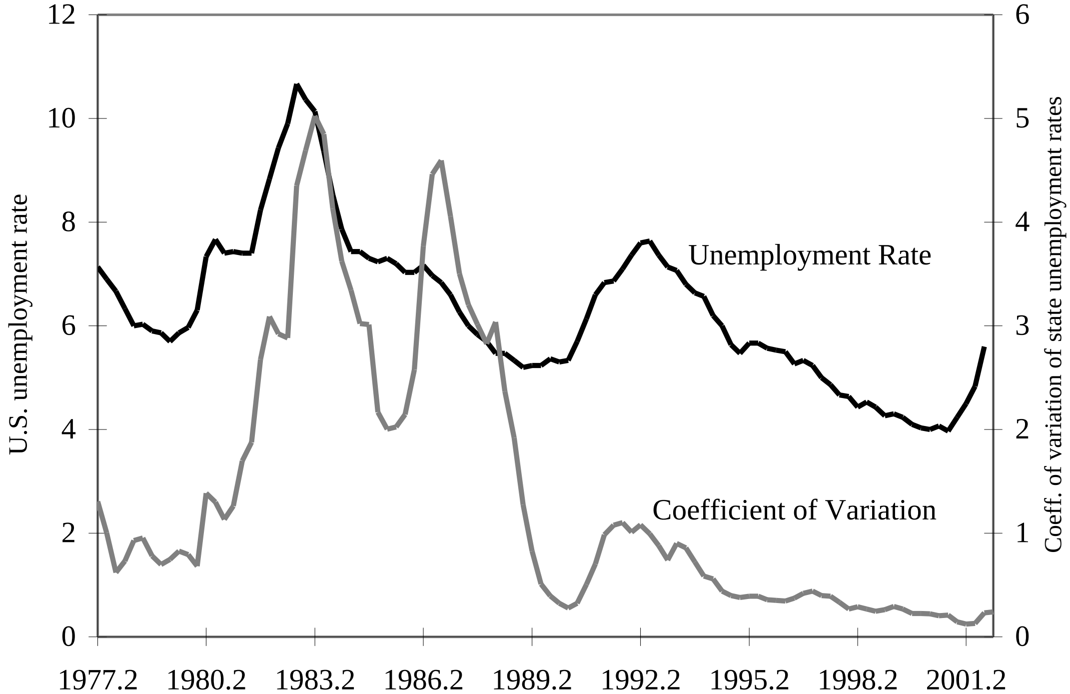

Figure 2. Changes in state unemployment rates during recessions

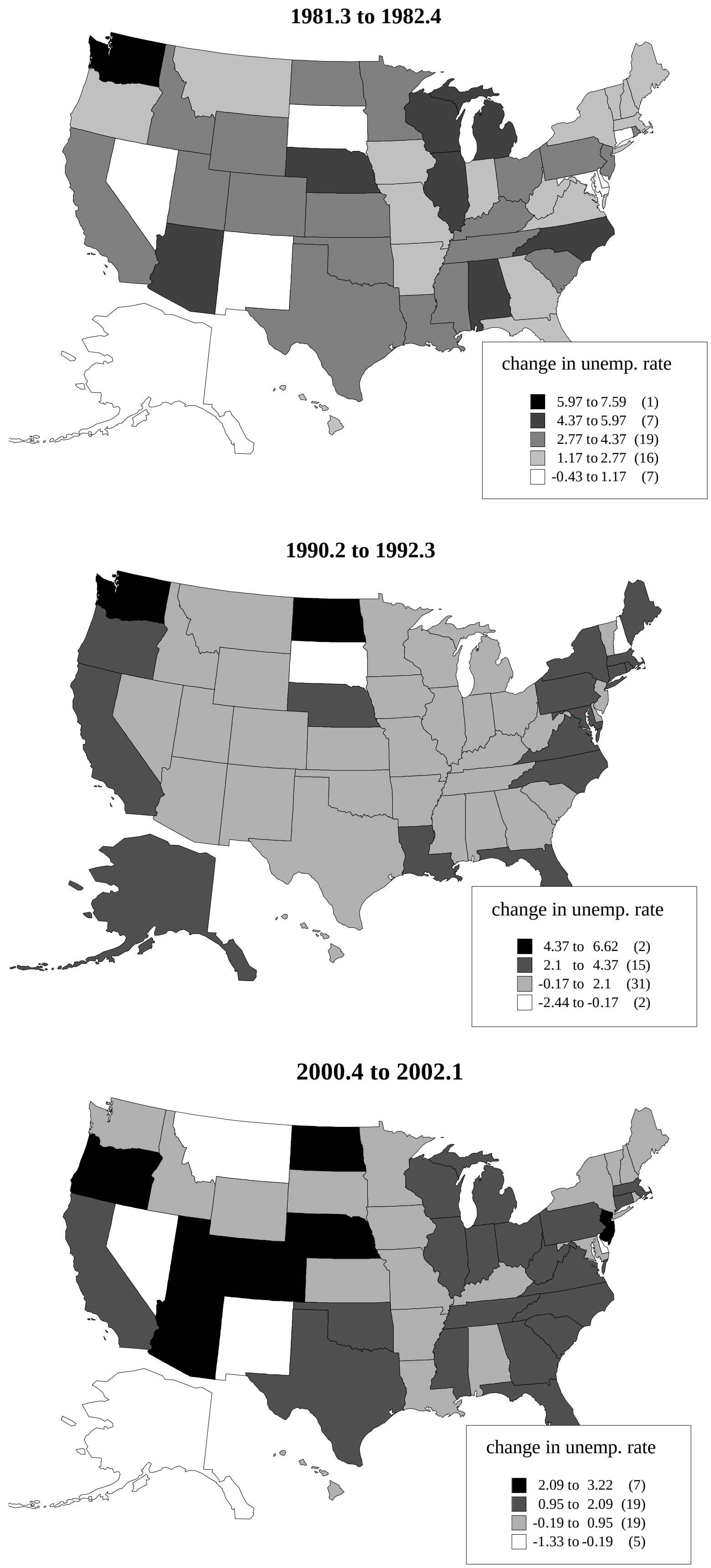

Figure 3. Wage inflation and employment growth

Figure 4. Wage inflation and the unemployment rate

Figure 5. The falling U.S. natural rate, 1982-2000